Use of multiple tracers for studying the inter-relationships between climate and recharge conditions of groundwater in a region of France: The past half-millennium

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Temporal variations in the noble gas temperature (*NGT*), the excess air component (*ΔNe*) and the deuterium excess (*d*) in groundwater from the Fontainebleau Sands Aquifer (France) reveal changes in European climate during the past half millennium. The reconstructions of the NGTs back to 1500 suggest cooler recharge conditions throughout the 16th-19th centuries than present. Moreover, the *NGTs* recorded periods of weak warming in the 17th-18th and cooling in the 19th that are in conformity with other temperature records for France and Europe. High ΔNe values seem to record periods of high intermittency of recharge events. Slightly lower amounts of *ΔNe* are observed in groundwater recharged in the 19th despite a slitghly higher precipitation rate. In the 17th-18th centuries, with slightly lower precipitation rates, more intermittent rainfall events probably induced larger variability of the water table and consequently larger amounts of air were trapped during recharge. The *ΔNe* in groundwater from this aquifer seems to be more linked to the oscillations of the water table produced by the temporal variability of the rain events than to the total amount of precipitation.

d varies in parallel with *NGTs*, and indicate a maximum in the period between 1700-1750. Inter-annual variations in the seasonality of precipitation and its intensity, combined with changes of the soil coverage in the recharge area, seems to be responsible for the variation observed in the *d* in groundwater.

Our reconstructed parameters (NGT, ΔNe and d) show noticeable relationships with available climate records. Such comprehensive studies of the link between climate and recharge conditions enhance our understanding of the effects of climate change and climate variability on groundwater resources sustanability.

Timescales of melt extraction from a heterogeneous mantle beneath the Central Indian Ridge at 19.2°S

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We propose to document the timescale of the magmatic processes occurring beneath the slow-spreading Central Indian Ridge (CIR, 19.2°S) through the study of the chemical variations recorded by the lavas erupted on-axis. The samples were collected along a 40 km-long profile made transverse to the ridge and running from the axial trough up to the Brunhes-Matuyama isochrone (~800 Ky, GIMNAUT cruise). The lavas are greatly homogeneous in term of Mg# (67 ± 2) but range from N-MORBs to E-MORBs in terms of trace element concentrations ($0.6<La/Sm_N< 3.4$). Their Sr-Nd isotope ratios start from the center of the isotopic field of the CIR lavas and overlap its enriched end. Trace element ratios plotted along the profile describe saw-tooth patterns characterized by enriched spikes regularly and symmetrically distributed on both sides of the ridge axis. Consequently, the lava compositions are an indicator of magmatic processes that have fluctuated periodically through time. Based on the position of the enriched lavas along the profile, the timescale of such magmatic processes has been estimated to 230 Ky. Fractional crystallization can be ruled out to explain the observed chemical variations. Thus, they reflect the variations through time of the primary melt composition, partly governed by mantle source heterogeneity according to the Sr-Nd isotopes. To reproduce the observed periodicity, we propose an interconnection between the source heterogeneity and the variation of the melting rates: The most enriched lavas are the products of very low melting of a fertile enriched mantle component. This component may have been specifically introduced in the melting column each ~230 Ky or the melt extraction modalities may have changed with the same timescale. Apart from these enriched events, mixing between enriched and depleted primary melts occurs normally due to magma genesis/aggregation and the enriched signatures are diluted into a N-MORB-type composition.